Hoisting

This chapter covers the following items

- Draw-works
- Hoisting tackle; including crown and traveling blocks, hooks and elevators
- Deadline anchors
- Drilling lines
- Derrick

Draw-works

- **Heart of the rig**
- **Enabling equipment to be run in and out of the hole**
- **Provide power for making or breaking joints**
- **Principle components: drumshaft group, catshaft and coring reel group, main drive shaft and jacketshaft group, rotary component group, and controls**

Drumshaft group

- **Hoisting drum to reel the line to raise and lower loads**
- **Brakes; used to stop the movement using the brake lever**
- **Cooling system; water cooling system to remove heat generated during braking**
- **Auxiliary brakes; hydrodynamic (hydraumatic) or eddy current (uses magnetic forces)**
    - **With hydromatic, braking effect increases with weight (depth) increase**
    - **Hydromatic used when electric supply on rig limited**
    - **On diesel electric rig use eddy current brake**
    - **Eddy current braking effect depends upon the intensity of the electromagnetic current**

Catshaft and coring reel group

- **Comprises the catheads, the catshaft assembly and the coring drum**

- **Catheads are sppol-shaped, rotating drum powered by the jacketshaft assembly**
- **Consists of friction and mechanical rotating heads**
- **Friction catheads used to transport heavy objects around the rig floor by means of a manila rope**
- **The mechanical catheads comprises the makeup catheads on the drillers side and the brake-out catheads on the opposite side**
- **Mechanical catheads are spooled with a suitable length of wire line connected to the tongs**
- **The tongs on the driller's side is called make-up tongs and on the other side called break-out tongs**
- **Coring reel drum contains sufficient small diameter (9/16 in) wire line to reach the bottom f the hole**
- **Used for lowering and retrieving any device to the hole bottom**

<u>Main drive shaft and jacket group</u>

- **On many modern rigs**
- **Used to generate electricity**
- **Electric cables used to deliver power to motors attached main drive power to the main drive shaft, rotary table and mud pumps**
- **Main drive shaft equipped with two sprockets connected by roller chains to high- and low-drive sprockets on the jackshaft**
- **The jackshaft connected to catshaft and drumshaft through roller chains and sprockets**
- **Engagement of the high- or low-drive sprockets, catshaft or hoisting drumshaft is achieved by sliding gear clutches**
- **This engagement is driven with four-speed gear box**
- **Reverse is obtained by reversing the rotation of the D.C. electric motors**

<u>Rotary countershaft group</u>

- **Required when the rotary table is powered directly from the draw-works**

- **Comprises all components required to transfer rotary motion to the rotary table**
- **Includes the rotary countershaft, drive-chain and sprockets, air clutch, inertia brake and controls**
- **In modern rigs, the rotary table is powered by a separate D.C. motor and drive shaft assembly**

Hoisting tackle

- **Block and tackle system used t handle weight of drill string**
- **Continuous line is wound around a number of fixed and traveling pulleys**
- **The line segments between sets of pulleys act to multiply the single pull exerted by the hoisting drum**
- **This allows many thousands of pounds of drill string or casing to be lowered into or pulled from hole**
- **It includes different components: crown block, traveling block and drilling hook, dead line anchor and weight indicator, and drilling line**

Crown block

- **Means of taking wire line from the hoisting drum to the traveling block**
- **Number of pulleys fastened to the top of the derrick**
- **The drilling line is reeved around the crown block and traveling bock sheaves**
- **One end comes to an anchoring clamp called dead line anchor**
- **The other end goes to the hoisting drum described as fast line**
- **During hoisting the drum spools more fast line than the distance traveled by the traveling block**
- **The speed of the dead line is zero while that of the fast line is equal to the number of drilling line times the speed of the traveling block**
- **Crown block must be positioned such that the fast line sheave is close to the center line of the hoisting drum**

- **The angle formed by the fast line and the vertical is called fleet angle**
- **Fleet angle should be less than 1.5 deg**
- **Crown block is a steel framework with the sheaves mounted parallel on a shaft**
- **The sheaves are mounted on a double-row tapered roller bearings to minimize friction**
- **A sheave for the line from coring reel shaft is also on the block**
- **Small sheave for the manila rope from friction catheads may be also found**

Traveling block and drilling hook

- **Similar to the crown block**
- **Manufactured from high quality steel, each mounted on large diameter of anti-friction bearings**
- **Sheaves diameter should be 30-35 times the diameter of the drilling line to prevent excessive wear and increase fatigue life of line**
- **Manufactured to be**
    - **Short and slim for less room**
    - **Heavy to overcome the drilling line friction**
    - **Free of protrusions and sharp edges for safety of workers**
- **Combined with the hook into one unit named "Hook Block"**
- **The hook is used to connect the traveling block to the swivel and the rest of the drill string**

Deadline anchor and weight indicators

- **A base and slightly rotatable drum attached to the rig floor**
- **Provide a means of securing the dead line and measuring the hook load**
- **Hook load measured by a sensitive load cell or pressure transformer**
- **A pressure signal is sent to the rig floor through a fluid filled hose connected to a weight indicator**

- **The weight indicators has two pointers; one shows total hook load and other weight on bit**

Drilling line

- **A wire rope made up of number of strands wound around a steel core**
- **Each strand contains a number of small wires wound around central core**
- **Several types of wire ropes:**
  - **Round strand**
  - **Flattened strand**
  - **Locked coil**
  - **Half locked**
  - **Multi-strand**
- **Difference in**
  - **Internal structure**
  - **Weight per unit length**
  - **Breaking strength**
  - **Number of wires in each strand**
  - **Number of strands**
  - **Type of core**
- **In oil well drilling, round-strand wire are only used**

Round-strand ropes

- **Widely used in most hoisting operation; oil or mining**
- **More economical than others**
- **Consists of six strands wound over a fiber core or a small wire rope**
- **The wire rope described by the number of strands**
- **Described as:**
- **Type A: either 6x9/9/1; means 6 strands each consists of 9 outer wires, 9 inner wires, and one central core, or 6x19, meaning 6 strands each contains 19 wires**
- **Type C: either 6x10/5/5/1 or 6x21**
- **Also described by the type of lay: Lang's lay or ordinary (regular) lay**

- **Lang's lay, wires and strands are twisted in the same directions; right hand or left hand**
- **This type of twist increases wire rope resistance to wear**
- **Ordinary lay; wires and strands twisted in opposite direction**
- **Advantage, easier to install and handle than lang's lay**

Drilling line design considerations

- **Typical line is round-strand, Lang's lay, 6x19 construction with independent wire rope core (IWRC)**
- **Sizes varies from ½ to 2 in (51 mm)**
- **Described by nominal diameter, mass per unit length and nominal strength**
- **Specifications given in API Spec 9A**

Static and dynamic load

- **Static crown load for two sheaves (SCL)= fast-line load+hook load+deadline load**

- $SCL = \frac{W}{2} + W + \frac{W}{2} = 2W$ .....(1)
- **For three sheaves**

- $SCL = \frac{W}{4} + W + \frac{W}{4} = \frac{3}{2}W$ .....(2)
- **For N lines**

- $SCL = \frac{W}{N} + W + \frac{W}{N} = (1 + \frac{2}{N})W$ .....(3)

Under dynamic conditions

- **Hook load (HL)**

- $W = \frac{FLxK(1-K^N)}{(1-K)}$ .....(4)
- **Fast line load (FL)**

- $FL = \frac{W(1-K)}{K(1-K^N)}$.....(5)
- **Block and tackle efficiency (EF)**
- $EF = \frac{W(1-K^N)}{N(1-K)}$.....(6)
- **Fast line during lowering (FL)**
- $FL_{lowering} = \frac{WK^{-N}(1-K)}{(1-K^N)}$.....(7)
- **Dead line load (DL)**
- $DL = \frac{HLxK^N}{NxEF}$.....(8)
- **Design factor (DF)**
- $DF = \frac{\text{nominal strength of wire rope (lb)}}{\text{Fastline load}}$.....(9)
- **Power requirement (P)**
- $P = \left(\frac{HL}{NxEF}\right)xNxV_L = \frac{HLxV_L}{EF}$.....(10)
- $P == \frac{HLxV_L}{EFx33000}. in \ \ horse\ power$.....(11)

Ton-miles of a drilling line

Round trip operation

- $T_r = 4WD + W_e(L_S + D)D + 2CD$.....(12)

- $T_r = \frac{D(L_S + D)W_e}{10560000} + \frac{D(M + C/2)}{2640000}\ \text{ton-mile}$.....(13)

Drilling operation

- $T_d = 3(T_r at\ d_2 + T_r at\ d_1) = 3(T_2 + T_1)$.....(14)

Coring operation

- $T_c = 2(T_2 + T_1)$.....(15)

Setting casing operation

- $T_s = \frac{D(L_S + D)W_{es}}{10560000} + \frac{MD}{2640000}\ \text{ton-mile}$.....(16)

The total ton-mile is calculated and the cut of length is determined from the tales depending on the size of the wire and the ton-mile between two cut-offs.

Wire rope diameter	Ton-mile between cut-off
1	600
1 1/8	800
1 ¼	1100
1 3/8	1900
1 ½	2600

API gives a table for the length of cut-off in terms of drum laps

Derricks

- **Structure of square cross-section constructed of special structure steel**
- **Yield strength greater than 33,000 psi**
- **Consists of four legs connected by horizontal structures**
- **Equipped with a substructure (derrick floor)**

- **The structure height above the ground varies with the substructure**
- **For base size 24-26 ft, height is 7.25 ft**
- **For base 30 ft, height can be 7.25, 10, or 14 ft**
- **Rating of the derricks is based on pipes setback load and wind velocity**
- **Derricks are designated by**
- **Height: the vertical distance along the neutral axis of the derrick leg from the top of the derrick floor joists to the bottom of the water table**
- **Base square: the distance from the heel to heel of the adjacent legs at the top of the base plate**
- **Window opening: distance measured parallel to the center line of the derrick from the top of the base plate**
- **Water table opening: an opening in the top of the derrick in which the crown block is fit**
- **Gin-pole is used to hoist the crown block to its place at the water table opening**
- **Gin-pole clearance is the distance between the header of the gin pole and the top of the crown block**

<u>Types of steel derrick</u>

- **Standard which is a bolted structure**
- **Portable (mast) moved as one unit on a truck or dismantled into a number of pin-jointed section, each is one truck load**